

# STUDY PLAN FOR BIOLOGICAL INVENTORIES SOUTHERN PLAINS NETWORK NATIONAL PARK SERVICE

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End date: March 31, 2005

Total project cost: \$286,000

Study Plan Cooperators:

National Park Service

Colorado Natural Heritage Program

New Mexico Natural Heritage Program

Texas Conservation Data Center

Kansas Natural Heritage Inventory

November 2000

## SPN Network and Project Overview

### Introduction

This study plan proposes the approach to be used by ten parks in the Southern Plains Network (SPN) to inventory vertebrates and vascular plants. The plan was written as a cooperative effort between the National Park Service and the Colorado and New Mexico Natural Heritage Programs, the Kansas Heritage Inventory, and the Texas Conservation Data Center (hereafter the Heritage Programs when referred to as a group).

The goal of the project is to provide park managers with documented vertebrate and vascular plant inventory information in an accessible and useful format. Much data already exists and a critical product of this study plan and the continuing inventory project is gathering, review, and input of quality assured data into standard NPS databases such as NPSpecies, the Natural Resource Bibliography (NPBib), and the Dataset Catalog.

Study objectives are:

1. Compile historic data for vertebrates and vascular plants believed to occur in SPN parks from a variety of sources including museum records of voucher specimens, previous studies, park databases, etc. and input these data into appropriate NPS databases.
2. Where quality data do not exist, conduct targeted field investigations to document the occurrence of a majority of the species of vertebrates and vascular plants occurring in SPN parks. Existing and new data will be evaluated to determine the completeness of the inventories. The goal is to document 90% of the species but may not be possible given available funds.
3. Describe the need for future studies to determine the distribution and relative abundance of species of special concern, such as threatened and endangered species, exotics, and other species of special management concern occurring within SPN park boundaries. Develop proposals (including methods and budgets) that individual parks or the SPN can use to seek additional funding to address these needs.
4. Gather inventory data by methods that will assist SPN parks in developing their park “vital signs” monitoring program.

The ten SPN parks are in Colorado, Kansas, New Mexico, Oklahoma, and Texas and are listed in Table 1 (hereafter parks will be referred to by their park codes as listed in the table). The parks are in the *temperate* or *subtropical steppe* ecoregional divisions described by Bailey (1994) except for CHIC, which is in the *prairie* ecoregional division. The Sand Creek Massacre site in Colorado may be acquired by the NPS. If that happens, Sand Creek will likely become part of SPN and the Network will work to address its biological inventory needs.

**Table 1.** Southern Plains Network Park units, park code, acreage, and ecoregional division.

State	Property	Park Code	Acreage	Bailey's (1994) Ecoregional Division	Notes
Colorado	Bent's Old Fort NHS	BEOL	799	Temperate steppe	
Kansas	Fort Larned NHS	FOLS	718	Temperate steppe	410 acres fee simple
New Mexico	Capulin Volcano NM	CAVO	793	Temperate/subtropical steppe border	
	Fort Union NM	FOUN	720	Subtropical steppe	
	Pecos NHP	PECO	6,800	Subtropical steppe	
Oklahoma	Chickasaw NRA	CHIC	9,889	Prairie	
	Washita Battlefield	WABA	326	Subtropical steppe	
Texas	Alibates Flint Quarries NM	ALFL	1,371	Subtropical steppe	Within and managed by LAMR
	Lake Meredith NRA	LAMR	46,349	Subtropical steppe	
	Lyndon B. Johnson NHP	LYJO	1,570	Subtropical steppe	

Seven SPN units (ALFL, BEOL, FOLS, FOUN, LYJO, PECO, and WABA) were established primarily for their cultural resources; two units (CHIC and LAMR) were established primarily for recreation and to protect urban water supplies; while CAVO was established for its natural resources. All the parks are deemed to have "significant natural resources" by NPS. While many natural resource issues are park specific, most SPN parks are concerned with non-native plants and ecological restoration and threatened and endangered species management (Table 2).

**Table 2.** Southern Plains Network general natural resource issues by property.

State	Property	Issues
Colorado	BEOL	Prairie and riparian restoration/non-native species management; prairie dog management; water quality and quantity
Kansas	FOLS	Prairie restoration
New Mexico	CAVO	Erosion along park road/exotic species/sensitive species
	FOUN	T&E/exotic plant identification; historic vegetation research; vegetation management within ruins and site
	PECO	Exotic plant invasion/sensitive species
Oklahoma	CHIC	Water quality and quantity, vegetation, and game species management.
	WABA	Exotic plant invasion/prairie restoration
Texas	ALFL	Restoration after catastrophic fire
	LAMR	Exotic plant (especially tamarisk) invasion, threatened and endangered species
	LYJO	

### Existing inventory information

The current inventory status of vertebrates and vascular plants for each park in the network was compiled during a series of site visits to each of the parks and subsequent communications to park managers, local universities, herbaria, museums, and other potential resources. We began with a workshop held in May 2000 at which we identified a preliminary set of experts for each park in the network and defined how we would implement the network standards defined by the Park Service. Following the workshop, we made site visits to all of the park units to collect existing data housed by the park or otherwise readily available from park personnel. The site visits allowed us to collect the park's information on presence/absence of

vertebrates and vascular plants as well as any existing data regarding that park's species of special management concern.

While visiting the parks we identified knowledgeable experts that had worked with the park in the past and would likely possess additional data and information. In some cases, we were able to also identify other sources of data that had not yet been identified by the park as a potential data source. For example as regards vascular plants at Bents Old Fort NHS, we were able to identify a local botany professor who had made collections from the park and cataloged the specimens at the park as well as the Rocky Mountain Herbarium at the University of Wyoming in Laramie. The collections housed at the Rocky Mountain Herbarium were verified by the herbarium, prior to being accepted into the herbarium's collection.

During the workshop we held in May 2000, we defined how we would implement the data standards set forth by the I&M program management based on the individual network considerations. For example, we determined that it is necessary to document each species occurrence with some sort of voucher, however this does not have to be a physical specimen and could be a published report by a reputable expert, or other relatively verifiable documentation. The standards used to define documentation of existing and future data collections are described in greater detail in the Documentation Standards section of this paper.

Based on the existing data available for each park, we were able to determine the information that remained to be collected to meet the Service's requirement that 90% of the vascular plants and vertebrates be documented for each park. To verify the level of completion toward the 90% rule for each park, we developed an expert list for each park based on the opinions of locally recognized experts. Often these experts were the Heritage Program zoologists and botanists familiar with the local area of each park, but also included other experts familiar with the area of each park. These lists can be found in the appendices (Appendices B-J).

### **SPN organization and study plan framework**

Overall network coordination is the responsibility of the Steering Committee consisting of one representative from each SPN park. The Regional I&M Coordinator is the current Chairperson. The conceptual plan for the network and the biological inventory project was developed during a series of meeting and workshops among the parks and Heritage Programs.

Park representatives and the Intermountain Region I&M Coordinator met in February 2000 to develop the SPN organization and select a cooperator. SPN considered informal proposals from Dr. Nick Parker with USGS-BRD at Texas Tech. Univ., Dr. Fred Smeins at Texas A&M Univ., and the five state Heritage Programs led by Joe Stevens with the Colorado Natural Heritage Program to provide assist the Network in conducting the project. The Steering Committee selected the Heritage Program to work with on the program.

SPN held a biological inventory planning workshop in May 2000 to develop the project. The Steering Committee, other park representatives, Heritage Program experts, Intermountain Region (IMR) I&M Coordinator, and (IMR) Vegetation Ecologist participated. The participants agreed on a project structure and standards and inventory priorities.

Heritage Program and IMR personnel held a writing workshop in August 2000 to outline and write sections of the study plan. Unfortunately, budget information was not available at the time. When each Heritage Program submitted its budget for a statistically rigorous project that would provide presence/absence data, distribution and abundance data for common species, and serve as a first monitoring survey the project was well over the target budget.

This final plan is scaled back to meet the target budget but only addresses the objective of provided documented species occurrence for most (hopefully %90) species that occur in each park.

The proposed structure for completing the SPN biological inventories follows state lines. To complete the biological inventories, the Colorado Natural Heritage Program will work with BEOL, the New Mexico Natural

Heritage Program will work with CAVO, FOUN, and PECO, the Kansas Heritage Inventory will work with FOLS, and the Texas Conservation Data Center will work with LAMR/ALFL and LYJO. The work will include continued data mining and management and new field inventories. Each cooperator will gather and input data in standard NPS database formats. The Colorado NHP will have overarching SPN network data management responsibility until the SPN receives permanent park vital signs monitoring funds at which time a SPN data manager will be hired and take over data management. This results in six project statement for the plan; one for each state plus a data management project statement (Table 3).

**Table 3.** Southern Plains Biological Inventory Project Schedule and Overall Budget

Project	FY 00	FY 01	FY 02	FY 03	FY 04	Totals
1. Data inventory and study plan.	\$53,000 <sup>a</sup>					\$53,000
2. BEOL: wetland plants and vertebrates		\$12,000				\$12,000
3. FOLS: vertebrates		\$6,000	\$6,000			\$12,000
4. CAVO, FOUN, and PECO: plants (except PECO) and vertebrates		\$32,000				\$32,000
5. CHIC and WABA: plants (not CHIC) and vertebrates					\$37,000	\$37,000
6. LAMR/ALFL and LYJO: plants and vertebrates			\$70,000	\$70,000		\$140,00
7. Data management		\$4,333 <sup>b</sup>	\$4,333 <sup>b</sup>	\$4,333 <sup>b</sup>	\$70,000 <sup>c</sup>	\$83,000
Total request from WASO I&M Biological Inventory budget	\$53,000	\$50,000	\$76,000	\$70,000	\$37,000	\$286,000 <sup>d</sup>

<sup>a</sup> \$13,000 of FY 00 funds carried over for data management in FY 01-03.

<sup>b</sup> From FY 00 funds, not included in FY01-04 total request from WASO I&M.

<sup>c</sup> \$70,000 for data management to come from “park vital signs” monitoring funds; amount not included in totals.

Inventory completeness will be assessed by comparing documented species lists with master species lists for each park. Master lists based on existing information, published and unpublished literature, and expert opinion of what likely occurs in each park have been assembled (see appendices).

Data management is critical to project success. The ten-park SPN has the lowest target funding amount of any NPS network and carving out too much for a separate data management function was judged inefficient. The project is designed so that each Heritage Program is responsible for data mining and for providing new data in standard NPS database formats. The Colorado Natural Heritage Program will receive funding to ensure quality data are entered into standard NPS databases electronically. In FY 04 or earlier, SPN should receive park vital signs monitoring funding and data management will continue by a SPN Network data manager.

## Existing Information and Proposed Activities

Little information exists about the occurrence of vascular plant and vertebrate species for most members of the SPN. Field investigations are proposed for all parks in the SPN to document the occurrence of a majority of the species for vascular plants and vertebrates. A tabulation of necessary field investigations is presented in Table 4. Detailed information on the existing data and proposed investigations is presented in the park-specific sections of this study plan.

**Table 4.** Field investigations needed to obtain 90% presence/absence for all vascular plant and vertebrate species. The levels of investigation are full (full investigation required), partial (partial investigation required), finished (the 90% level has been met), in progress (adequate project currently underway), and N/A (not applicable, taxa is not on the property).

Field Investigations Needed To Obtain 90% Presence/Absence						
State	Property	Vegetation	Fish	Amphibians and Reptiles	Breeding Birds	Mammals
Colorado	BEOL	Partial	Partial	Full	Full	Full
Kansas	FOLS	Partial	Full	Full	Full	Full
New Mexico	CAVO	Full	NA	Full	Full	Full
	FOUN	Partial	N/A	Full	Full	Full
	PECO	Partial	Partial	Full	Full	Finished
Oklahoma	CHIC	Finished	Finished	Full	Partial	Full
	WABA	Full	Full	In Progress	In Progress	In Progress
Texas	ALFL	Full	N/A	Full	Full	Full
	LAMR	Full	Full	Full	Full	Full
	LYJO	Full	Full	Full	Finished	Full

Each network park also identified species and areas of management concern, which require inventory information. These are listed in Table 5. Since funds are limited and so much basic inventory information is still needed, the Network proposes no special inventories for these. Instead, each park, in consultation with their Heritage Program partner, will develop study proposals for these species that they will use in seeking additional funding to meet their needs.

**Table 5.** Southern Plains Network National Park units species or areas of management concern requiring in-depth inventory.

State	Property	Species	Type of information needed	Notes
Colorado	BEOL	Black-tailed prairie dog	Distribution, abundance	Warranted for federal listing
		Wetland areas	Species composition of plant and fish species	Cattail marsh, possible Arkansas Darter habitat.
		Tamarisk	Distribution and abundance	Baseline information on control effort effects
Kansas	FOLS	Black-tailed prairie dog	Distribution and abundance	Warranted for federal listing
New Mexico	CAVO	Alberta Arctic butterfly	Abundance	Endemic
		Non-native plants	Species and distribution	
	FOUN	Natural vegetation of recently disturbed soil	Species composition and distribution	Control of species in disturbed areas; revegetation with native grasses.
	PECO	Scotch thistle	Distribution and abundance	
Dwarf Milkweed		Distribution and Abundance	T&E	
Oklahoma	CHIC	Burned eastern red cedar invasion areas	Species composition and distribution	Baseline information on control effort effects
		Recently abandoned agricultural weed infested areas	Species composition and distribution	Weed infested areas that have never been investigated.
		Echinacea	Systematics and distribution	Poached and rare species
	WABA	Reclamation areas	Species composition and distribution	Baseline information on reclamation projects
Tamarisk invasion zone		Species composition and distribution	Infestation zone has never been investigated	
Texas	ALFL	Swift Fox	Distribution	Federal listing candidate
		Texas horned lizard	Distribution	State Listed
	LAMR	Arkansas River shiner	Distribution and abundance	Federally listed threatened
		Swift fox	Distribution	Federal listing candidate
		Texas horned lizard	Distribution	State listed
		Black-tailed prairie dog	Distribution and abundance	Warranted for federal listing
LYJO	None			

The first draft study plan was statistically rigorous and would have allowed scientific quantification of inventory completeness (species richness using mark-recapture models) as well as documenting distribution and abundance for many species. It also provided a sound framework for using the field inventories as the first round of monitoring for many vertebrates and vascular plants. Unfortunately, the resulting cost was well over the target budget of \$280,302. Much study design work was done for the first draft and is included here. That work will be very useful when SPN begins planning its park vital signs monitoring and has been provided to the Network in electronic format.



## Documentation Standards

### General

The documentation standards for the Southern Plains Network Plan for Biological Inventories were agreed upon at the May 2000 writing workshop. They follow the guidelines set up by the NPS Inventory and Monitoring Program (NPS 1998, 1999, Fancy 2000, Wotawa and Fancy 2000). In general, these standards call for investigators to document all pre-existing data and reports, pertinent proposed sampling effort information, and the resulting information from future sampling efforts into the appropriate NPS databases (NPSpecies, Dataset Catalog, and NPBib), and to follow all of the rules and regulations that pertain to biological sampling protocol on NPS lands. The NPS databases to be used are described in detail in the Data Management section.

Specimens collected in National Park Service areas are considered property of the National Park Service. To meet the requirements of 36CFR 2.5g, collected specimens will be labeled with NPS accession and catalog numbers. The collection data must be entered into the NPS Automated National Catalog System Plus (ANCS+). Copies of field notes, raw data, final reports, and other records associated with the research proposal will also be accessioned and cataloged with the specimens.

Each state Heritage Program will produce a final report for their portion of the biological inventory. The reports will be provided to each park, to the WASO I&M Program and the NPS Technical Information Center (TIC will archive the reports). The work will also be documented in the NPS Investigator Annual Report Database.

Fieldwork will be permitted according to NPS research permitting guidance. Whenever possible, NPS will provide investigators research permits that allow work in multiple parks.

### Master Species Lists

One of the products of this study plan are master species lists of potential vascular plant and vertebrate species occurring in the parks. The lists will be used to guide inventory efforts and to determine if the 90% vouched species goal has been met for vascular plants and vertebrates. They were assembled from existing park species lists, scientific articles and reports, field data taken in the parks and from surrounding lands with similar habitats, and advice from experts on the various taxa. The final lists were quality reviewed by taxa experts. The master lists are included as Appendices A through J and are arranged by park and taxonomic class (vascular plants, fish, amphibians and reptiles, breeding birds, and mammals).

### Voucher Standards

For existing information on vascular plant and vertebrate species, records will be accepted and included in NPS databases only if it is considered as vouched. The acceptable types of vouchers for all taxa include certified documentation, physical specimens, photographic evidence, auditory evidence, and positive visual identification. Types of acceptable certified documentation include scientific journal articles and technical reports by a qualified professional in that field. Natural Heritage Program cooperators will determine whether existing records are adequately documented for inclusion. Physical specimens must be identified by a qualified professional and should be either part of the NPS on-site collection, or be curated by a natural history museum or collection that has a standing agreement with the NPS. T&E species will not be collected (unless found dead). Auditory evidence should be in the form of a recording, when possible. When not possible, an expert in that field of study must be used in order for the record to be considered valid. Positive visual identification should also be performed by qualified personnel, and should only be used when other types of identification are not possible. T&E species should always be identified by a qualified expert, and photographic evidence is preferred. Each taxa has a separate level of acceptability for

voucher types, and not all of the types mentioned above are used for all taxa. The following sections outline these standards. Voucher types are listed in order by the level of preference.

#### Vascular Plants

Vouchers for plant species must be in the form of physical specimens and listed in certified references. Physical specimens must be vouched by a qualified botanist, dry pressed, and stored to NPS standards. It is suggested that at least two voucher specimens exist for each species. One specimen should be included in the NPS on-site herbarium collection, and at least one specimen should be curated by a herbarium, museum, or natural history collection that has a standing agreement with the NPS. Certified references are acceptable for historical data, but physical specimens are preferred when possible. Additional species observed during sampling will require a physical specimen as a voucher.

#### Fish Species

Vouchers for fish species may be in the form of photographic evidence, scientific journal articles and technical reports, visual identification, and physical specimens. Photographic evidence should be used whenever possible, making sure that positive identification is possible. Journal articles and technical reports must be written by qualified fish biologists. Visual identification should be performed by qualified personnel, and when photographic evidence does not give positive identification. Physical specimens are required only in the cases of hard to identify species, and never for T&E species.

#### Amphibians and Reptiles

Vouchers for amphibian and reptile species may be in the form of photographic evidence, scientific journal articles and technical reports, auditory recognition, visual identification, and physical specimens. Photographic evidence should be used whenever possible, making sure that positive identification is possible. Photographic vouchers will be included in technical reports provided to NPS. Journal articles and technical reports must be written by qualified herpetologists. Auditory recognition must only be performed by a qualified wildlife biologist or herpetologist, preferably with sound recording evidence used as a voucher. Visual identification must be performed by a qualified wildlife biologist or herpetologist, and should only be used in the case where other means of vouching are not possible. Physical specimens are required only for hard to identify species (except T&E species).

#### Breeding Birds

Vouchers for breeding bird species may be in the form of photographs or sound recordings, scientific journal articles and technical reports, and physical specimens (only when the bird is found dead). Field data will be collected by biologists familiar with visual and audio identification of birds of the area. Journal articles and technical reports must be written by qualified biologists. Photographic vouchers will be included in technical reports provided to NPS.

#### Mammals

Vouchers for mammal species may be in the form of photographic evidence, scientific journal articles and technical reports, and physical specimens. Photographic evidence should be used whenever possible, making sure that positive identification is possible. Photographic voucher evidence for mammal species includes photographs of individual mammals, and photographs of tracks that can be positively identified to the species level by a qualified biologist. Photographic vouchers will be included in technical reports provided to NPS. Journal articles and technical reports must be written by qualified biologists. Physical specimens should only be taken in the case of species that are very difficult to identify otherwise (except for T&E species where photographic evidence is preferred).

## Data Management Standards

### General

A major objectives of the biological inventory is sound information management to ensure data are stored and transferred accurately, secured from loss or damage, and made available to decision makers in a timely and understandable manner.

Each Heritage Program will follow NPS Data Management Guidelines. They will each be responsible for quality assuring the data they gather and providing hard and electronic copies to NPS (in standard NPS database formats, see descriptions below).

The Colorado Natural Heritage Program will have an overarching data management role. They will be responsible for quality assurance and merging separate project databases into one SPN database and for uploading those data to servicewide NPS databases.

The data collected from field inventory will be recorded on field sheets developed for the inventory project based on the Database Template so data are easily incorporated into standard NPS applications such as the Theme Manager. Original field sheets will be copied to provide a second copy for each record. The data will be entered into the electronic database (based on the Database Template), printed, and reviewed by a second individual. This quality control step necessary to ensure that field data collected are accurately transferred to electronic format.

The Heritage Programs will enter species occurrence data into NPSpecies within three months of the end of the field collection period for any year. Any pertinent literature located during the project and new reports and articles generated will be entered by the Heritage Programs into NPBib. Likewise pertinent inventory data sets located or generated by the project will be entered into the Dataset Catalog.

The Heritage Programs will use data managers, hourly, and student hourly technicians to enter and verify the electronic transcription of the data. The data will be entered into the appropriate databases provided by the NPS.

### Data management tools to be used for the SPN biological inventory

The **I&M Database Template** is a flexible, relational database in MS Access for storing inventory and vital signs monitoring data (including raw data collected during field studies). This relational Access database can be used as a standalone database or in conjunction with the GIS Theme Manager to enter, store, retrieve, and otherwise manage natural resource information. The template has a core database structure that can be modified and built upon by different parks and networks depending on the components of their inventory and monitoring program and the specific sampling protocols they use.

The **Dataset Catalog** is a tool for keeping an inventory and providing abbreviated metadata about a variety of natural resource data sets, from physical files and photographs to digital scientific and spatial data. The one-page input and report forms provide a straightforward way to document all types of resource data that may or may not have meet formal metadata standards. As with other NRPC applications, the master version of the Dataset Catalog will be available through a website and will be linked to NPSpecies (the NPS Species database) and the NPBib bibliography, and it will also be possible to download a version in MS Access from the website.

**NPSpecies** is the standard NPS database for documenting species occurrence data.

**NPBib** is the standard NPS database for documenting bibliographic references.

**Synthesis** is an information management system for efficiently locating, organizing, integrating, and disseminating data and information. Synthesis presents the user with a simple, graphical user interface that

functions as a gateway to information that may be stored on local computers, networks, intranets, or the Internet. From this single gateway, a user may view and integrate many types of information including text-based documents, photographic libraries, databases, spreadsheets, presentation graphics, geographic information system (GIS) data, bibliographies, Internet-based information, and decision support systems. All of the databases listed below, including the NPBib, NPSpecies, Dataset Catalog, GIS Theme Manager, and the MS Access I&M Database Template, will operate as stand-alone applications or can be accessed through Synthesis.

The **NPS Theme Manager** is a GIS application in ArcView that makes natural resource information more available and useful to managers, interpreters, resource specialists, maintenance personnel, and others. The Theme Manager can be used as a standalone application, or can be launched from within Synthesis. It can also be used in conjunction with the MS Access I&M database as a means of organizing and displaying integrated natural resource information. The Theme Manager has the full functionality and spatial data analysis capabilities of ArcView for those who routinely use GIS, but can also be used by someone with only a few hours of training to display integrated natural resource information for planning, park operations, and decision-making.

## **Sampling Strategy**

### **General**

Surveys will be done by habitat, utilizing aerial photographs, historic information, knowledge from previous visits to the parks, and especially the expertise of Heritage Program biologists. Sampling will target habitat types in order to maximize number of species detected. The sampling methods will vary by taxa, and are described below. In general, surveys will be time-constrained area searches. Every effort will be made to distribute survey effort broadly across ensure all areas of the parks.

A more rigorous sampling design, utilizing a systematic random sampling scheme, with a randomized 50x50m grid as a sampling base was originally conceived. This sampling scheme was rejected due to budget constraints, but may be utilized for future inventory and monitoring efforts for distribution and abundance of biological resources. A description of this scheme is given in the Monitoring section of the plan.

Even the most consistently-conducted survey will yield varying results over time, due to extrinsic factors such as weather patterns and intrinsic factors such as plant/animal population dynamics. In order to capture seasonal variation within a single year, while minimizing project costs, we will conduct most inventories using two to three sampling periods for each year. At the end of each sampling period, the inventory projects should be reviewed to make sure that the sampling goals are being met. Number of samples, sampling frequency and intensity will be modified to ensure that the project objectives and budget and budget constraints are met

### **Taxon Specific Sampling Strategies**

#### Vascular Plants

Vascular plants will be sampled subjectively based on expertise and knowledge of Heritage Program personnel. Field investigations may include any combination area searches, plots, and transect line searches. All vascular plant species sampled will be tallied by growth form, average height, and general habitat conditions. A small number of area plots will be used whenever possible, in order to obtain a small measure of statistical objectivity.

Field personnel will carry a vouched plant species list for the property, and take voucher specimens when applicable. When a species is collected, at least three specimens will be taken. They will be dry pressed, and identified by a qualified taxonomist.

Vegetation will be sampled two to three times per sampling season for presence/absence, depending on the habitat and information desired. Sampling is proposed for one sampling season, in most cases.

#### Fish Species

Fish will be sampled subjectively based on expertise and knowledge of Heritage Program personnel. The number of samples taken will depend on the size of the body of water and level of information required. Fish inventories will take place only once per year for presence/absence and two to three times per year for abundance and distribution. Sampling is proposed for one sampling season, in most cases.

#### Amphibians, Reptiles, and Mammals

Most of the sampling for amphibians and reptiles will be performed jointly with surveys for mammal species. They will be sampled subjectively based on expertise and knowledge of Heritage Program personnel. Field sampling will include any combination visual encounter surveys, trapping array stations, camera and tracking plate stations, and coverboard stations. The locations of trapping arrays, cameras and tracking plates, and coverboard stations will be determined by Heritage Program staff (in consultation with park staff), in order to maximize the amount of information obtained from each trapping station. The

suggested field methods are those proposed by Songer and Lomolino (1997), Lomolino and Perrault (2000, in press), and Heyer et al. (1994) and described in more detail below.

Trapping Array stations will be locked open and not baited for five days, followed by seven days of baited trapping. Each station will include an array of live-capture and pitfall traps. Mammals are traditionally captured in both the live capture and the pitfall traps. Small amphibian and reptile species are traditionally found in the pitfall traps only. Captured animals will be recorded by species, sex (when possible), weight (when applicable), and will be marked for re-capture (temporary marking is preferred). Traps will be checked at least twice each active sampling day. Each trapping array station will include:

- 1) Five - one gallon (#10 food or coffee cans) pitfall traps in a line at 1 meter intervals, located approximately five to six meters from station center.
- 2) One - 4x5x15 inch Sherman trap, baited with peanut butter and oats, located up to five meters from station center.
- 3) Three - 3x3x9 inch Sherman traps, baited with peanut butter and oats, located up to five meters of station center.
- 4) One - 5x5x16 inch Tomahawk trap, baited with a combination of meat or fish (any type of meat or fish), and vegetarian bait (apples, peanut butter, carrots, cracked corn, etc.), located within six meters of station center.
- 5) One - 6x6x24 inch Tomahawk trap, baited with meat and vegetable foodstuffs, located within six meters of station center.

Coverboard stations will be located at least 50 meters away from the nearest trapping array station, in a direct line towards the next sampling array station, and at least 100 meters away from the nearest camera and tracking plate station. This assures that animals that utilize the coverboards are not disturbed by the larger animals drawn to baited areas. Coverboard stations will consist of four coverboards placed within six meters of plot center. All coverboards will measure approximately 0.66 meters by 1.33 meters. Two of the coverboards at each station will be made out of roofing tin, and two will be made out of either chipboard or plywood. Species that prefer dry microhabitats have been shown to prefer coverboards made of metal, and species that prefer wetter microhabitats have been shown to prefer coverboards made of wood (Grant et. al 1992). They are placed flat on the ground, and propped up with enough room underneath to allow reptile, amphibian, and small mammal species to crawl under them. Field investigators simply lift up the coverboards while walking the transect lines between trapping array stations, and record the number of specimens observed. Coverboard stations should be placed on the site for at least two months in advance of sampling for best results, and are to be checked for each of the 12 days utilized to set up and trap at the trapping array and camera stations.

There should be approximately one camera and tracking plate station for every three to four trapping array stations. Camera and tracking plate stations are to be located 100 meters from the nearest trapping array stations, and should be placed in a direct line towards the next trapping array station when possible. Camera and Tracking Plate Stations will consist of one camera and tracking plate setup, placed within six meters of station center. Like coverboards, they are run for the entire 12-day sampling regime called for with the trapping array stations (Songer and Lomolino 1997, Lomolino and Perrault 2000, in press).

Tracking plate stations record the tracks of animals that come to take bait that is placed in the center of a one meter square piece of coated sheet metal. A hole is cut into the middle of the tracking plate (2.125 inch diameter), and a PVC pipe (two inch diameter) is driven through the hole and into the ground to hold the tracking plate in place. The tracking plate is covered with a suspension of carpenter's chalk in alcohol (two parts powdered carpenters chalk to five parts 70% reagent grade alcohol). A kabob of raw meat is placed in top of the pipe at the center of the tracking plate, and other food items (cracked corn, apples, canned fish, etc.) are placed around the base of the pipe for bait. When animals walk across the plate, they leave track evidence. Photographs of tracks may then be used as vouchers.

Cameras are set up next to the tracking plate, and with the bait in the viewfinder. When warm-blooded wildlife investigates the bait, an infrared sensor activates the camera. The photographs are to be used as vouchers. Camera setups consist of:

- 1) One point and shoot type 35mm camera with automatic flash, wrapped in plastic with a hole cut for the lens opening.
- 2) Mounted on a two by two inch post hammered into the ground, with holes drilled into it for camera mounting screws.
- 3) One infrared trigger mechanism.

Visual encounter surveys (VES) for amphibian, reptile, and mammal species (Heyer et al.1994), will be performed within potential habitats, and will be performed between trapping array stations. Field investigators will thoroughly search these areas using a variety of techniques, such as turning over rocks and logs and looking into crevices in rock and cracks in structures.

There are some field survey techniques that will be utilized only for amphibian and reptile species. They include fixed-point auditory, and night road surveys. The fixed-point auditory surveys will be conducted around all freshwater habitats to listen to and record frog and toad choruses. Each point will be positioned at least 200 m from an adjacent point to prevent double counting of individuals. With such a large distance, many small, temporal pools will have a single point. Chorusing frogs will be identified by call.

Night road surveys will be conducted following or during heavy rains in spring and summer. Night surveys will be conducted after dark by slowly driving roads looking for reptiles and amphibians crossing roadways. Detected individuals will be captured, identified, and collected, if no specimen for the species is currently held. A relative frequency of occurrence can be calculated for each species based upon the total number observed per road mile.

Field personnel should carry a vouched species list for the property, and take voucher specimens when applicable. A camera should be taken into the field at all times to obtain vouchers of the animal species observed. Physical specimens should only be taken when there is no other way to identify the species. All voucher specimens and photographs should be turned in to the NPS property in question, or placed into an approved collection.

Mammal species will be sampled one to two times per year, usually in the spring to summer months only. Amphibian and reptile species should be sampled jointly with mammal species. Sampling is proposed for one sampling season, in most cases.

#### Breeding Birds

Because of the expense required to conduct multiple surveys each year, field surveys will focus on breeding birds only. Bird surveys will utilize either a time constrained area search or variable circular plots conducted along transects within chosen habitats. Use of VCPs will maximize the amount of information gathered for a relatively small number of sampling points. Points will be chosen to prevent overlap of samples. All sampling will be performed twice per year, in order capture early and late breeding season birds. Sampling will take place from early to middle spring for early season, and from late spring to early summer to capture late season breeding birds.

#### **Suggested vertebrate and vascular plant monitoring design**

Originally, the Heritage Programs proposed a statistically sound and rigorous sampling design that would have allowed for an unbiased estimate of inventory completeness, gathered distribution and abundance information for many common species, and provided a framework for future monitoring. It is a systematic random sampling scheme, with a randomized 50x50m grid as a sampling framework. The sampling grids were produced using GIS, giving accurate geographic positions for all potential sample points locatable in the field with a GPS. Each grid was randomly placed over the park and rotated by a randomly selected angular distance. Gridline intersections are centers of potential monitoring sample points. Gridlines can also be utilized as transects. Potential transects and points for each park are logically numbered for each. This sampling framework will be made available to the NPS and the individual parks by December, 2000.

Sample points that are utilized for field studies should be permanently marked when possible. One method is the use of unobtrusive permanent metal tags placed as close to plot center as is possible. Plot

information (such as plot number) is permanently engraved onto a metal tag, and the tag is secured to a rebar marker, post, or tree at the center of the plot that is positioned using GPS technology. When this is not possible, researchers should use GPS to locate sample points as needed.

Zones of interest were delineated using physical characteristics such as elevation, slope, aspect, soil series, or other criteria that are less subject to physical and temporal displacement than vegetation. Exceptions to this rule were open water, urban and built up, culturally managed, and areas that are of special interest to the resource managers (T&E species habitats, aggressive weed problem areas, active reclamation areas, etc.). Open water and urban areas have intuitive sampling restrictions associated with them. Culturally managed areas include active agricultural, and reclamation areas that are scheduled for repeated cultural manipulation. Separately delineated T&E and weed infestation areas have to be of primary concern to resource managers, and are not able to be delineated using terrain.

Delineated areas of interest can be sampled at different frequencies, depending on the level of information required. Sample points for future studies are to be selected using a systematic sample of the potential sample points with a random start. An example of this is to choose an approximate number of plots per unit area, based on previous studies or expert opinion, and to systematically choose the plots in that area with a random start. Since each potential plot center on a 50x50m grid spatially represents 0.25 hectares (0.62 acres), a spatially derived sub-sampling framework can be used to sample from the existing sampling grid to the approximate desired density. This is referred to as probability sampling (Steel and Torrie 1980). It accomplishes many of the goals of traditional stratification schemes (decreasing sample variance), while avoiding the statistical problems of unequal probability design (Chochran 1977).

The base sampling grid should be used as a framework for potential sample sites. It is not to be used as a blind template that lacks all practicality. Not all potential sample points can be sampled for all species. Examples of this include the fact that fish species must be sampled in aquatic habitats, and the limitations inherent in sampling urban and high use areas. The innate differences between taxa also require that different sampling regimes and intensities be used for certain groups of organisms. Investigators should use good judgment in addressing these issues, while not compromising the established sampling design.

Aerial photographs, topographic maps, and other information resources should be utilized before crews go into the field to make sure that special sub-habitats are not missed while sampling. In the event that some important habitats or species are missed by the designated sampling regime, those areas should be investigated in addition to the prescribed original sampling plan, and the location should be noted as accurately as possible for future reference.